

# Health & Safety

# Report

Worker Health and Safety Branch

HS-1842

**Review Of Chlorine Illnesses When Used  
In And Around Swimming Pools In California  
From 1995 To 1999**

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## **Executive Summary**

From 1995 to 1999, 250 illnesses or injuries occurred from the use of chlorine in and around swimming pools. This review was initiated as a result of three episodes reported in San Diego County involving failure of the chlorine injection systems to shut off when the filtering system is turned off. All three episodes involved multiple exposures to children and adults. The Department of Pesticide Regulation (DPR) Pesticide Illness Surveillance Program (PISP) database was used to find cases where illnesses or injuries occurred from chlorine used in and around pools and spas. The DPR PISP receives reports in which pesticides appear to have caused harm and catalogs these into a database. The cases reviewed were those where WH&S scientists found that the pesticide exposure had been at least a possible contributing factor to the illness or injury. The cases also include people exposed that did not handle the material, but were in the area of use; these would be considered non-occupational illnesses or injuries. During the review, three additional episodes were found that occurred because the pool chlorination system was not shut down during maintenance. These six episodes appear to be in violation of the Food and Agriculture Code under general standards of care when applying a pesticide. These illness episodes also appear to have violated the environmental health requirements for swimming pools under the California Code of Regulations (CCR) Title 22, section 65525, requiring the "pools water purification system to be kept in operation whenever the pool is available for use." All six sites made changes to their filtering and chlorination systems as a result of the incidents. The systems now automatically shut down when water pressure drops below set parameters or the flow stops.

In just over one-third of the cases, appropriate protective equipment was not used when handling chlorine or performing equipment maintenance. This most often involved lack of eye protection. In about one-fifth of the cases, training requirements for handling chlorine were not met. Individuals often reported more than one symptom, including difficulty breathing, throat irritation, chest discomfort, coughing, headache, dizziness and nausea. These symptoms are consistent with chlorine exposure since chlorine is a primary irritant to the mucous membranes of the eyes, nose, and throat, and to the linings of the respiratory tract.

In general, the County Agricultural Commissioners' staff does not routinely inspect swimming pool operators. However, many do send out information packets on the requirements for handling disinfectants and sanitizers in the non-agricultural workplace. Further information on handling pool chemicals can be obtained online through the U. S. Environmental Protection Agency and the non-profit National Swimming Pool Foundation.

CCR Title 22, section 65521 requires that the "pool shall be under the supervision of a person who is fully capable of, and shall assume responsibility for, compliance with all requirements relating to pool operation, maintenance and safety of bathers." Additionally, CCR Title 3, section 6724 requires all pesticide handlers (which includes equipment maintenance workers) be trained prior to working with a pesticide. From the review of case studies, it appears that pool maintenance workers may not be receiving proper training.

## **Introduction**

The Department of Pesticide Regulation (DPR) received a letter from the San Diego County Agricultural Commissioner concerning three episodes involving the use of chlorine injected into swimming pools<sup>1</sup>. In that letter, she explains that all three episodes involved multiple exposures to children and adults and there was a common theme in the exposures. The chlorine injection systems did not have a mechanism to automatically close valves when the filter pump was not operating. This lack of a shutoff device caused chlorine to build up in the lines and when the filter pump was turned back on a large bolus of chlorine was released all at once into the pool area. People in the vicinity of the outlet became exposed to high chlorine concentrations. Under California law, DPR is the agency responsible for registering and regulating pesticides, including chlorine. The letter and the three episodes prompted the Worker Health and Safety Branch to evaluate illness cases involving the use of chlorine in swimming pools over a five-year period from 1995 to 1999 and to identify other possible patterns of exposure. The DPR Pesticide Illness Surveillance Program (PISP) receives reports in which pesticides appear to have caused harm and catalogs these into a database. This database was used to extract cases involving chlorine exposure.

## **Methods**

The PISP database was used to find cases of illness or injury associated with chlorine used in and around pools and spas<sup>2</sup>. The cases reviewed were those that WH&S scientists found chlorine to be at least a possible contributing factor to the illness or injury. Cases that had insufficient data to evaluate or evidence established an unlikely or unrelated relationship were excluded from the review. Descriptions of the events leading up to the illnesses were reviewed to discern possible causes. The descriptions were based on information reported by the investigator of the episodes. The cases were reviewed for use of protective equipment, adequate training, equipment failures, types of illnesses or injuries such as eye, skin, or breathing difficulty and general circumstances related to exposure. This includes those people exposed that are not part of the application but are in the area of use and are considered non-occupational illnesses or injuries.

Additionally, to view their current practices, site visits were conducted at two of the San Diego sites where the injection systems did not shut off when the filter pumps were turned off.

## **Results**

There were 250 illnesses or injuries reported for the five-year period 1995 to 1999. Table I presents a summary by year of the number of individual cases and the number of episodes accounting for all the individuals. Seven episodes involved six or more people accounting for 62 illnesses or injuries, another nine episodes involved two people in each and one involved three people. Table II presents the five counties with 10 or more individual cases over the five-year period. The number of reported individuals exposed is influenced by the number of months that are conducive to swimming and the population density for that county. For San Luis Obispo County, one episode where the chlorination system continued running when the filter system was shut off and people remained in the pool area accounted for nine of the ten reported individual exposures.

Table I. Number of individuals and episodes involving illness or injury from exposure to chlorine used in pools and spas

Year	Number of individuals	Number of episodes
1995	61	45
1996	69	55
1997	28	20
1998	52	24
1999	40	31
Total	250	175

Table II. Counties having ten or more total individual cases from 1995 to 1999 involving illness or injury from exposure to chlorine used in pools and spas

County	Number of individuals	Number of episodes
Los Angeles	42	32
San Diego	36	12
San Francisco	21	5
Orange	12	11
San Luis Obispo	10	2

Six episodes were identified that appear to be related to the lack of automatic shutoffs when the pool filtration system is turned off. These episodes resulted from apparent violations of the California Code of Regulations, Title 3, Section 6600(b) perform all pest control in a careful and effective manner or (c) use only methods and equipment suitable to insure proper application of pesticides. A number of the episodes also involved violations for training and use of protective equipment. During the site visits to the two San Diego swimming pools, we noted that major changes in the filtering and chlorination systems had been made as a result of the exposure episodes. These systems are now wired to shut off with the pool pump and flow control switches were installed in the water line in the event water pressure should drop. Additionally, they are setup with an alarm system to go off if parameters programmed into the system are not met, such as chlorine concentrations, pH balance and water flow. The other four sites involved in cluster illnesses also reported making suggested changes to their pool systems, adding flow control switches and rewiring the metering devices to stop chlorine injection into the lines when the pumps are turned off.

Eye injury or irritation was reported in 112 of the 250 cases. The other 138 cases noted one or more of the following symptoms: breathing difficulty, throat irritation, chest discomfort, coughing, headache, dizziness and nausea. Individuals most often reported more than one of these symptoms. Most of the reported symptoms are consistent with chlorine exposure since chlorine is a primary irritant to the mucous membranes of the eyes, nose, and throat, and to the linings of the respiratory tract<sup>3</sup>. Twenty people also noted skin irritations or rashes along with other symptoms.

In just over one-third of the cases, no protective equipment was used when handling chlorine or performing equipment maintenance. These most often involved lack of eye protection. Workers

were performing what they considered routine tasks or equipment maintenance when an unexpected release of chlorine occurred. Examples include filling a chlorinator when the material got in the eyes, pouring liquid chlorine into the pool and it splashes in the eye, or performing repairs on pool equipment when a release of chlorine occurs. During repairs, hose or valve leaks also occurred while the system was still under pressure and material sprayed into the worker's face.

In about one-fifth of the cases, the investigation found that employees were not adequately trained for handling chlorine. There were two instances where untrained workers filled the wrong containers with chlorine causing an immediate reaction with the muriatic acid in the container. In a number of cases workers got a strong smell of chlorine while loading the liquid into tanks, changing containers, or handling the tablets.

Maintenance workers were also exposed to chlorine due to failures of pumps, hoses, gauges, o-rings, gaskets or valve fittings. Investigations found that when changing cylinders workers do not always close the valve properly and the chlorine line is not depressurized prior to disconnection. When the line is loosened, chlorine is released under pressure, spraying the worker. Maintenance employees may also work in small rooms with little or no ventilation.

There were thirty cases where the cause of exposure could not be completely evaluated. Some of these were swim instructors or physical therapists developing skin or eye irritation after spending their workdays in a pool or spa. Chlorine pool levels were either not known or within normal limits. In one episode, the chlorine levels were on the high side of the permissible amounts (3 ppm) before being corrected to a range of 1 – 1.5 ppm. In some cases, the investigator was unable to obtain sufficient information to determine the cause of exposure due to inability to contact the parties involved.

A typical liquid chlorine container used at a pool facility is shown in Picture 1; these containers vary in size. Picture 2 shows the top of the same container and hoses used to remove the material. Picture 3 illustrates a muriatic acid service container inside a containment barrel. Picture 4 shows an automatic pressure control switch that will turn the system off when water flow drops. Pictures 5 and 6 are examples of automatic chemical feeders and sensors for pH and sanitizer activity, respectively. As noted from the pictures, there is a considerable amount of plumbing in a large pool facility. These large facilities require knowledgeable individuals to design, install and safely maintain the chlorination and filtration systems.

Picture 1. Two hundred gallon chlorine container shown with service container label.



Picture 2. Top of chlorine container showing hoses leading to and from metering device.



Picture 3. Muriatic acid container placed in drum to prevent mixing with chlorine if spill occurs.



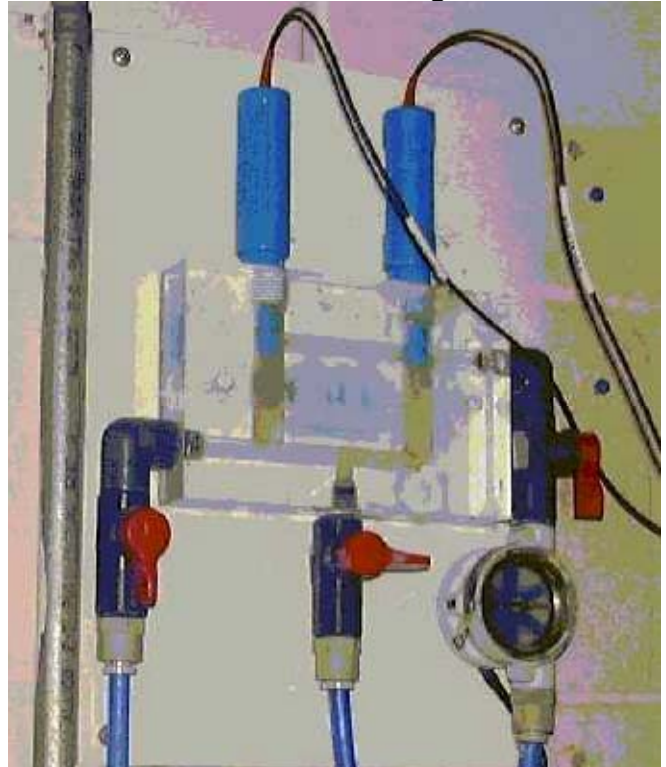
Picture 4. Inline automatic pressure switch to shut down system when water flow drops.



Picture 5. Automatic chemical feeders for control of pH and sanitizer.



Picture 6. Sensors for monitoring pH and sanitizer, with flow meter shown bottom right corner.



### Selected case summaries

Automatic shutoff valves are important safety devices that can prevent exposure of people in the pool areas. The following incidents demonstrate this:

- Two maintenance workers were conducting a scheduled service on the filter and all pumps were turned off. The workers left the room and a lifeguard came in at the scheduled time to check chemical concentrations in the pool and found them low. The area was not posted to inform people about the maintenance activity. The lifeguard turned the feeder pumps on, but did not notice the filter pump was off. The maintenance workers decided to finish the maintenance another time and the filter pump was turned on. As a result, the mixture of gas in the line was pumped out in the pool area, exposing those in the area. An environmental health specialist report recommended rewiring the system so feeders turn on and off with the main pump and installing pressure valves in the system to shut off system completely if water pressure is too low.
- A worker, noticing low chlorine concentration, began checking the equipment to determine the cause of the problem. He found the chlorine cylinders were empty. After replacing the cylinders, the chlorinating system still did not function properly. A hissing sound indicated chlorine was passing through the vent diaphragm and leaking outside near the pool area. As a result, 22 people sought medical attention. These exposures may have been prevented with a

high/low pressure switch that shuts the chlorinating system down if a leak occurs. In addition, the worker was not trained in maintaining the chlorination system.

- Maintenance workers installing new bypass valves reported they shut down the entire filter and chlorination system. When the system was turned back on, residual material in the lines was flushed into the pool. A strong odor developed in the pool area exposing at least seventeen children.
- A maintenance person took both pool filters off-line to clean and flush them. The process took about thirty minutes. During this time the meters used to control chlorination and pH were in the on position. Gas formed in the line and when the filters were brought back up this material was released into the pool. As the chlorine gas came to the surface children in the pool were exposed to high concentrations.
- In another incident, a chlorinator was left in the manual on position causing a pool to become over chlorinated. Normally, an automatic mode switch turns the chlorine gas off when the correct concentration of chemical is reached, but the switch was not set in the automatic position. The control switch was in an unsecured area and everyone in the pool area had access to the room. It could not be determined who turned the switch off or if it was a malicious act. The switch location is now secured.
- An additional episode occurred in 2001 when the chlorinator pump did not shut off automatically as water flow into the pool stopped. While the water flow was off, the chemical was still metered into the line. The injection pump required manual shut off. When the water flow was restarted, an excessive concentration of chlorine was sent into the pool resulting in exposure to those in the pool area.

The mixture of chlorine and muriatic acid or water results in a toxic gas. This type of incident is often the result of carelessness or lack of training.

- A maintenance worker, noticing the chlorine level was low, accidentally poured muriatic acid into a chlorine bucket in the pump room. Gas developed and got into the ventilation system of a nearby community center. As a result, the building required evacuation. The pool area also required evacuation when the doors to the pump room were opened and fans were installed for ventilation. The maintenance worker had limited training.
- A pool site recently moved the pool chemicals to a secondary facility. A pool employee noticed the bulk chlorine container for the pool getting low. The employee grabbed the nearest chemical container, not knowing that the chlorine was moved out of that building. As he refilled the container, a gas cloud formed.
- A maintenance worker pumped muriatic acid into a swimming pool's chlorine tank and an immediate chemical reaction developed exposing the worker and a nearby instructor.
- An apartment complex maintenance worker put chlorine tablets into a bucket, set the bucket down and walked away to do another task. Other materials and water in the bucket reacted



with the chlorine causing an explosion. The fire department was called and as they added water, a number of smaller explosions occurred.

Three episodes involved workers exposed to chlorine that appear related to curiosity on how the chlorination system works. Workers had difficulty breathing upon taking apart equipment that was part of an electrolytic process to chlorinate the pool water. No chlorine is added to the pool in this process, the pools are "saltwater" and by passing the salted water over electrodes, chlorine gas is generated from the chloride ion in the salt. The individuals involved in these episodes were not properly trained. Servicing of these pool chlorination systems is to be completed only by qualified technicians.

## **Discussion**

In California, CCR, Title 22, Section 65525 requires "the pool water purification system shall be kept in operation whenever the pool is available for use". This regulation, established for sanitation, would, if followed, also reduce the number of individuals exposed to chlorine. In the first six case studies presented, the automatic shutoffs for the systems were either overridden or not used. Following the regulatory requirements provides a measure of safety of people using the pools.

Previously, this branch reviewed chlorine illnesses in 1982<sup>4</sup> and 1987<sup>5</sup>. During the 1982 review, the branch went through reports filed with the Department of Industrial Relations' Division of Labor Statistics and found 820 cases involving products containing chlorine including 102 cases of use around swimming pools. An additional 150 cases occurred during the processing of agricultural commodities, including canneries and packinghouses. Causes of episodes occurring at canneries and packinghouses were similar to those occurring around swimming pools. For example, mixing incompatible chemicals or an untrained worker adding too much material to the commodity. Cannery episodes also occurred inside buildings where a large number of people may be exposed. At the time of the report, chlorine use accounted for approximately one third of the total pesticides used in California<sup>6</sup>. In 1987, two cluster illnesses involving 62 people occurred when gas cylinders were changed at swimming pool facilities. In one instance, the worker turned the valve to open and then disconnected the tank. This 1987 report concluded "since both training and mandatory eye protection are covered by existing pesticide safety regulations, it would appear that there is a need is to heighten awareness of these regulations among workers who handle swimming pool chemicals and inform them of the hazards presented by pool chlorine, muriatic acid and other pool products."

Currently, County Agricultural Commissioners (CAC) in California send out information packets on the requirements for handling disinfectants and sanitizers in the non-agricultural workplace. The information includes labeling requirements, how to find personal protective equipment requirements, reporting possible pesticide exposure, employer responsibility for training workers using disinfectants and sanitizers and the worker's right to be informed of potential hazards. In general, the CAC does not routinely inspect swimming pool operators. As new pool facilities are built and because of turnover at existing pool facilities, there is the possibility they will not be aware of the requirements.

Further information on the handling of pool chemicals can be obtained online through the U. S. Environmental Protection Agency in a pamphlet titled “Safe Storage and Handling of Swimming Pool Chemicals”<sup>7</sup>. This publication also references other government and industry operated organizations disseminating information on the safe handling of chlorine. The Chlorine Institute<sup>8</sup> is a trade association involved in the safe use of chlorine products. They have available materials that can be used in training workers in the safe use of chlorine or sodium hypochlorite. The non-profit National Swimming Pool Foundation<sup>9</sup> offers courses to certify pool and spa operators. Information is provided on pool and spa chemistry, testing, treatment, filtration, maintenance and automatic feeding equipment. Information is readily available to operators of pool facilities.

Though information is available for safely handling pool chemicals, labels for liquid chlorinating compounds do not contain information on safety devices needed to prevent inadvertent release of chlorine. Chlorine liquefied gas labels refer to using only specifically designed dispensing equipment. Pool chemical labels are unlike agricultural pesticide labels used in chemigation. Chemigation labels list specific safety devices and include automatic check valves, solenoid operated valves or reduced-pressure backflow preventers to stop the pesticide from being withdrawn if the system shuts down. While newer pool chlorination and filtration systems incorporate a number of safety devices, some older systems may not have safety devices installed in the event of system failure. The individuals responsible for the operation of these pool facilities could be unaware of the possible hazard.

While specific safety devices could have prevented these cluster illnesses, there were many smaller episodes that occurred because of poor training or lack of personal protective equipment.

“It is easy to respect things we don’t use frequently”. However, “Familiarity breeds contempt”. Over time we tend to forget and start to believe “there’s no real hazard here”<sup>10</sup>.

## **Recommendations**

- Ensure proper training of handlers, which includes maintenance personnel. Training should be specific to the chlorination system workers will be using or maintaining.
- Always use required personal protective equipment, especially goggles when handling any chlorine product.
- Control access to filter/chlorination system areas.
- Install automatic shutoff devices, flow control switches and alarms for system failure.
- During maintenance, keep people out of the pool and unnecessary personnel out of filter/chlorination system area.
- Post signs or lockout equipment during maintenance and repair of pool systems.
- Label valves, hoses, supply lines and show direction of flows for pool systems.
- Person responsible for the pool maintenance should perform regular inspections to insure safety of the pools chlorination system.

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